Haptic Interface

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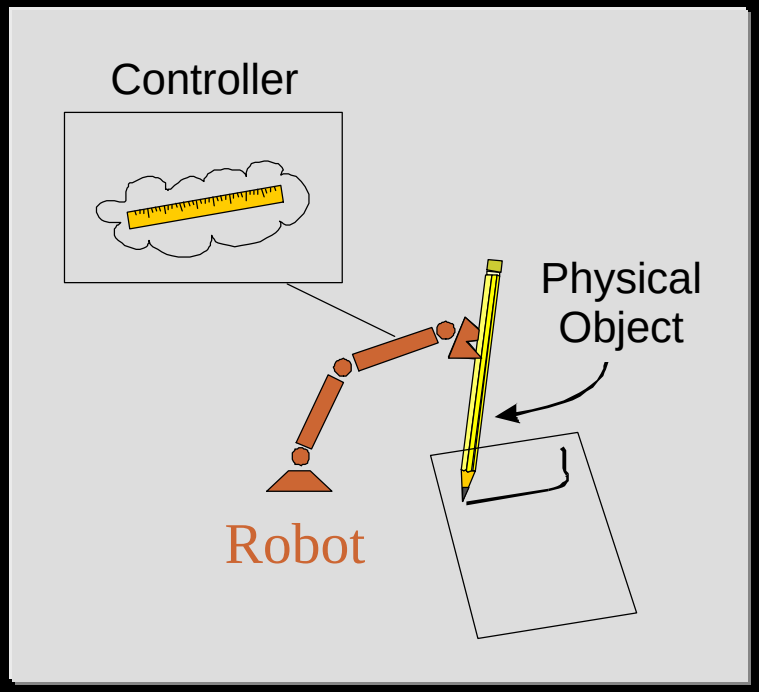
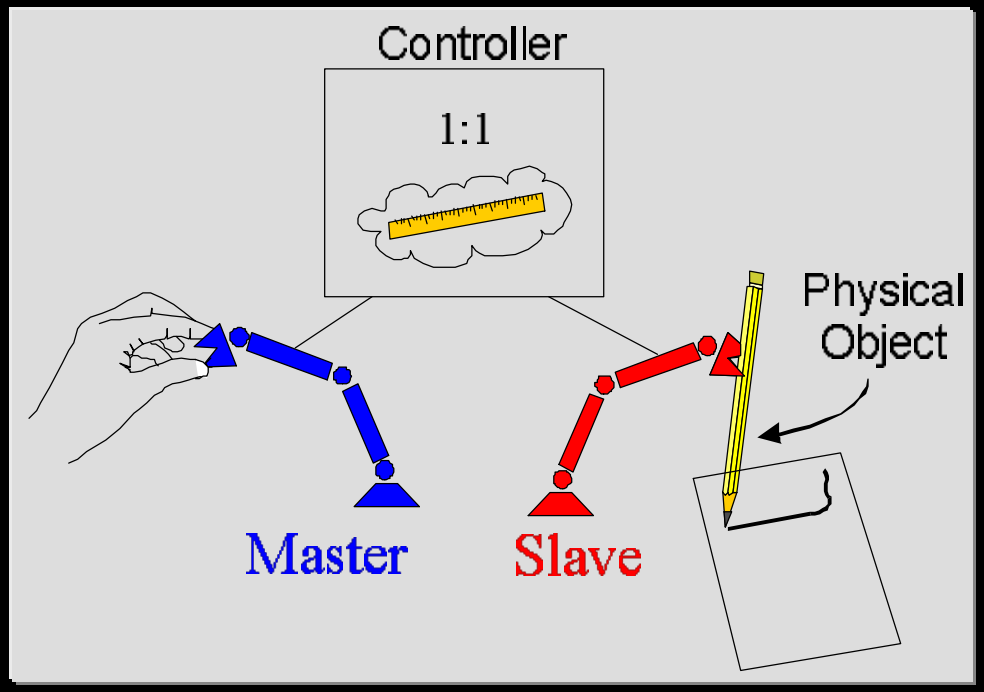
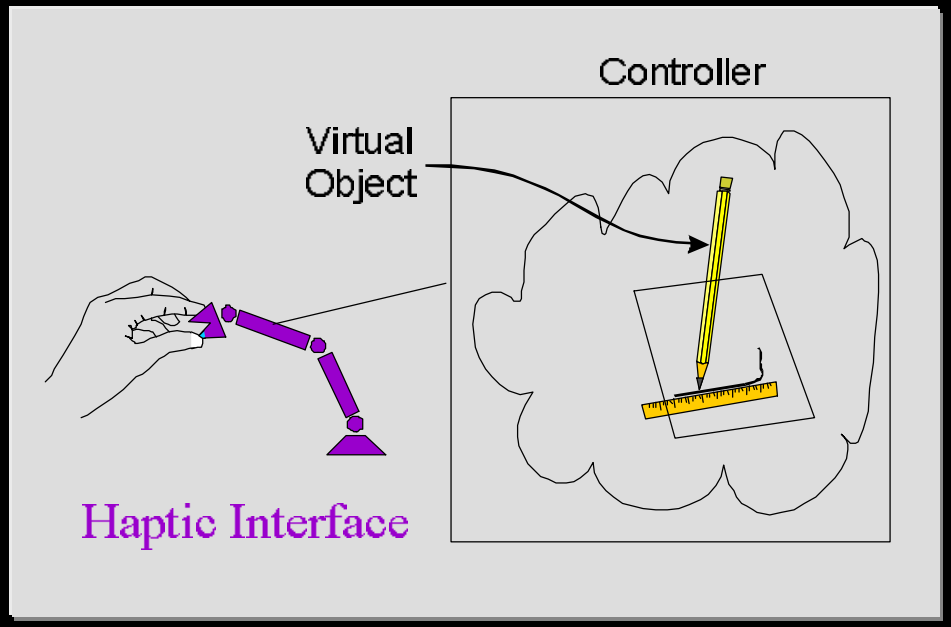
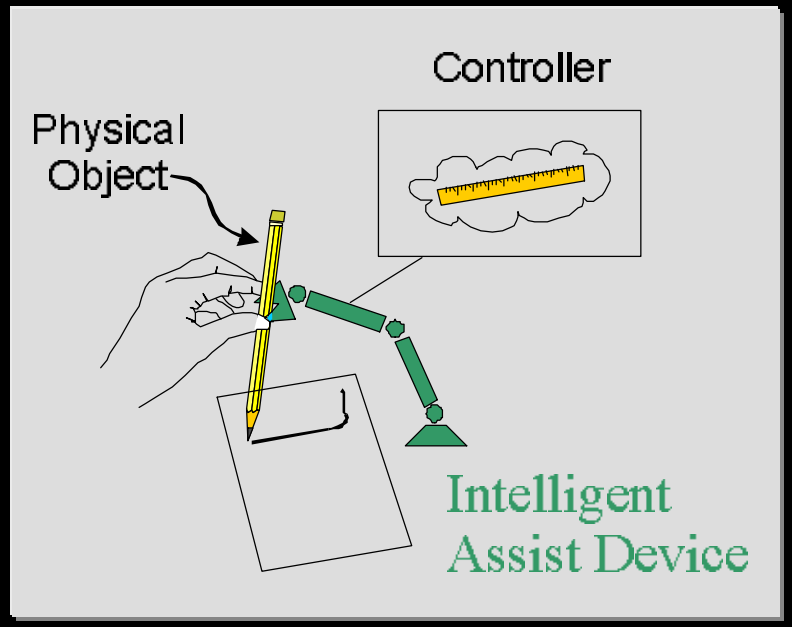
Outline

- Human-robot interaction -- a brief taxonomy
- State-of-the-art in haptic devices
- Some of what we know about haptics
- Some challenges in haptics
- Cobots -- what they are and why they're relevant
- Concluding observations


Controller
Physical
Object
Robot


Controller
1:1
Physical
Object
Master
Slave


Controller
Virtual
Object
Haptic Interface


Controller
Physical
Object
Intelligent
Assist Device

State-of-the-art in haptic devices

- A sampling of devices
  - small and large
  - handle-based and exoskeletal

Feel-It Mouse

- Logitech (licensed from Immersion Corp.)
- Available 9/99, $99
- Guesstimated specs:
  - 2 dof
  - 0.5”x0.5”
  - 5 oz peak force

Phantom

- SensAble Devices
- A few thousand dollars
- 3 dof
- 6”x5”x5”
- 1.45 lb peak force

SpacePen

- Immersion Corp
  - licensed from Cybernet
- 6 dof
- Body-scale workspace

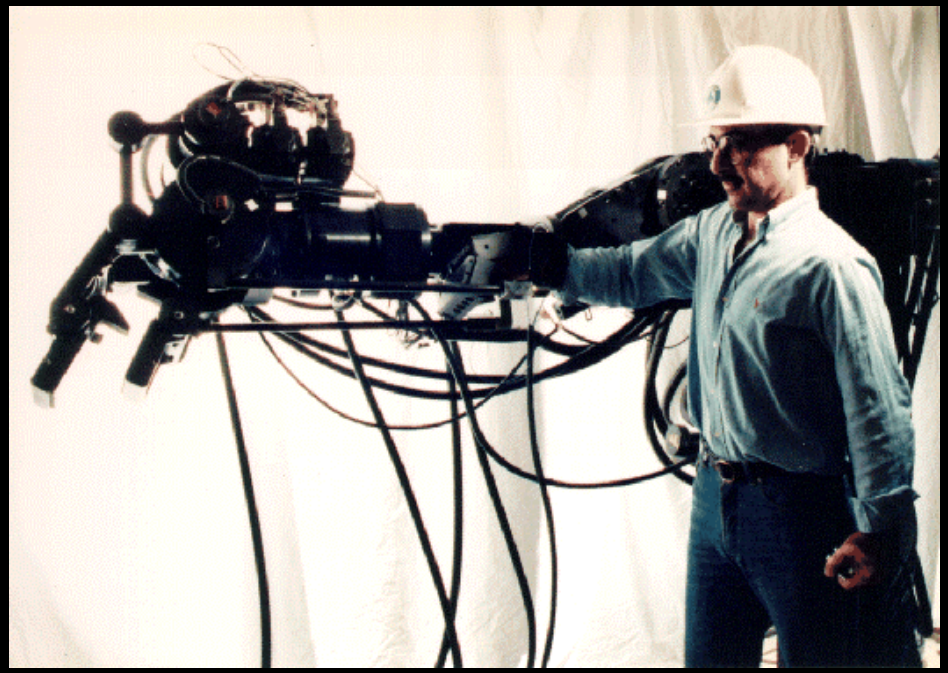
CyberGrasp

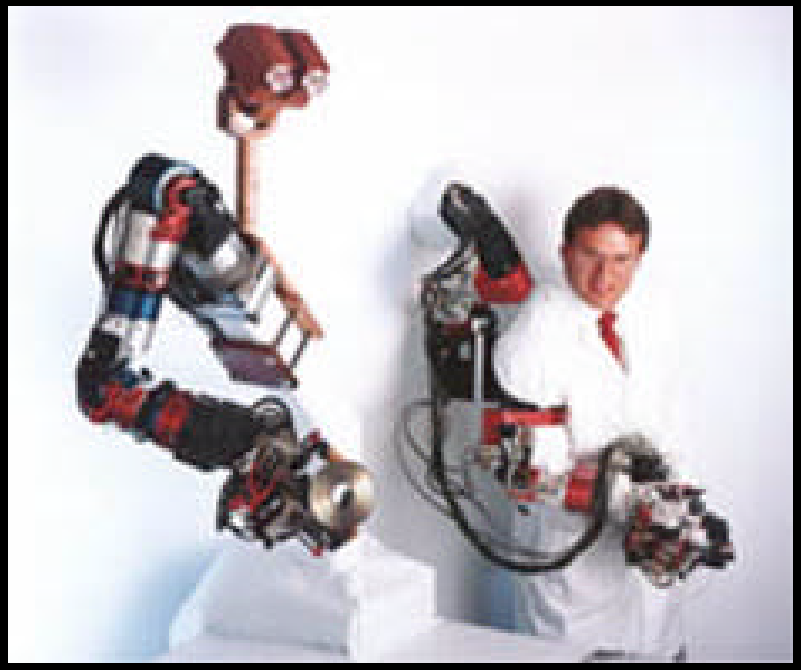
- Virtex Corp.

- Exoskeleton for the hand
- 2.8 lbs continuous force per finger

Full-Arm and Body Devices

- Kazerooni's extenders
- SARCOS' Dextrous Arm Master





Other exoskeletons

- EFF
  - Bergamasco, Pisa
  - 7 dof
- PHI
  - Hurmuzlu, SMU
  - 4 dof

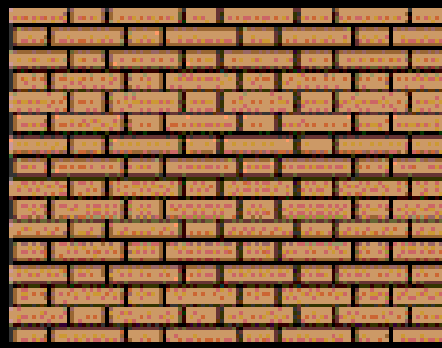
Some of what we know...

- Transmissions!!!!
- Update rates >500 Hz
- Stiffness >8000 N/m
  - for small-scale displays
  - not enough known about scaling
- Distal attribution

Challenge: dynamic range

Impedance devices

Admittance devices



More Challenges

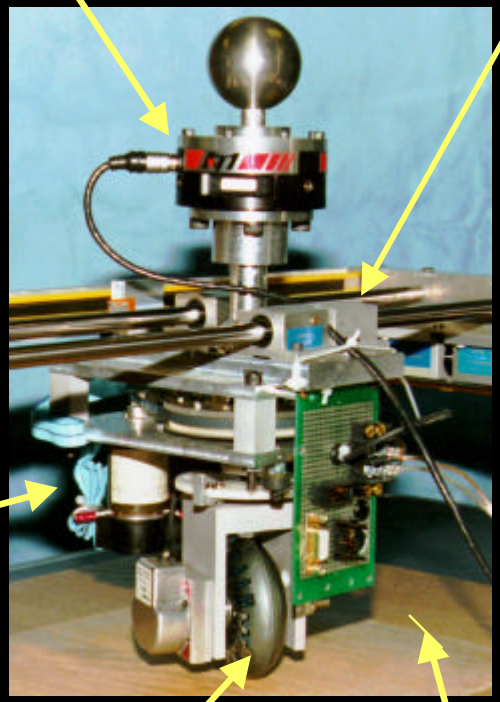
- understanding haptic perception
- high degree-of-freedom devices
- large-scale displays

Cobots

A cobot is a robot that won't move on its own, but will *guide and assist* motions imparted by a human operator

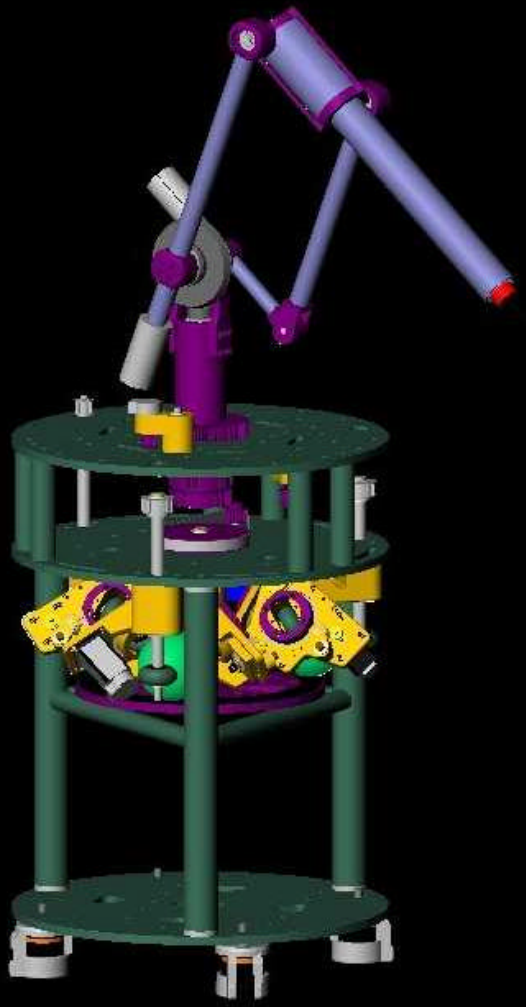
Cobots

- Cobots implement virtual surfaces via “servo-steered” joints
- Cobotic surfaces are programmable, passive, smooth and hard



The simplest cobot: a single wheel rolling on a plane

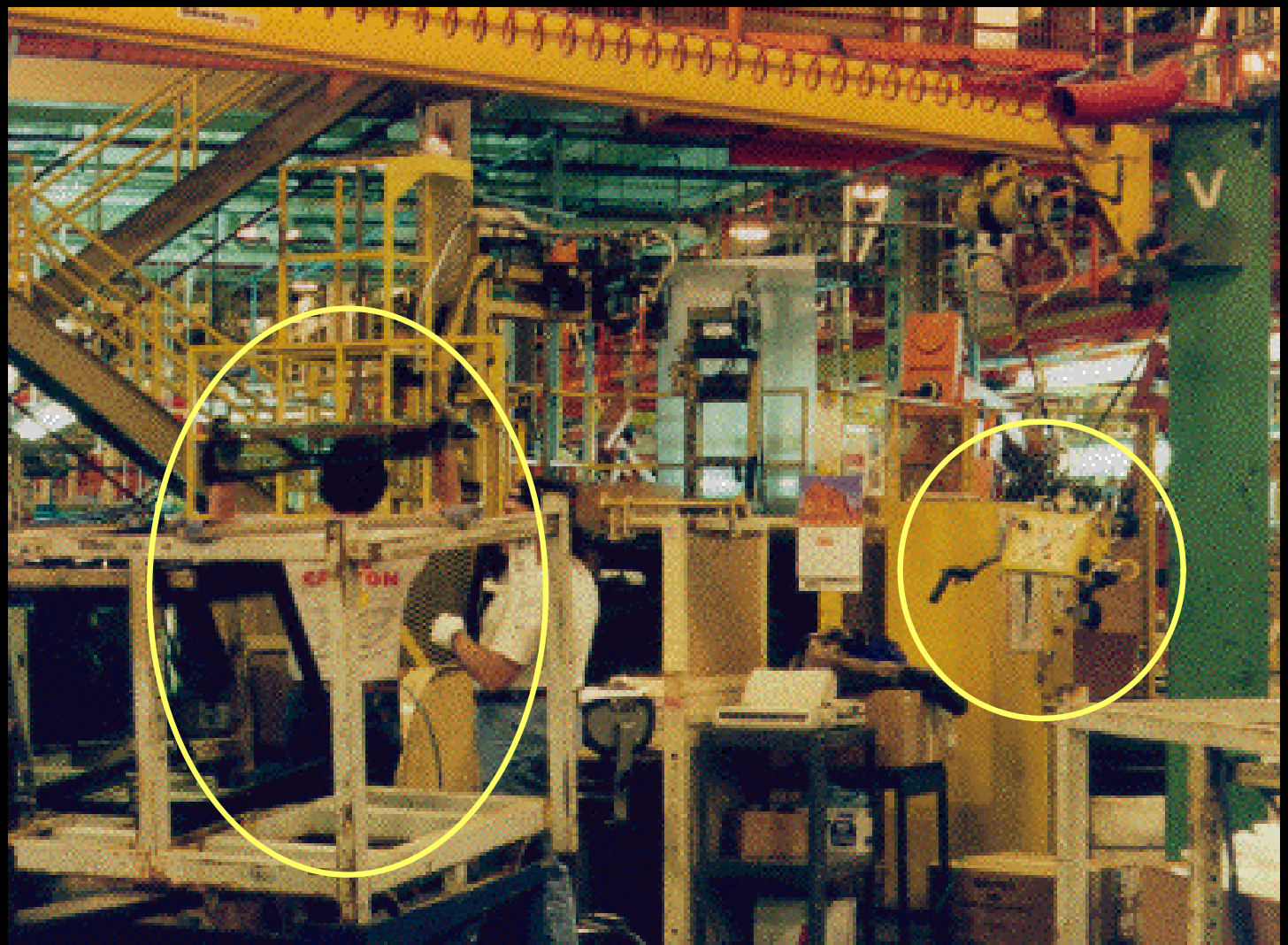
Other cobots...



Why cobots are relevant

- Low power consumption
- Reaction forces stem from the mechanics of the cobot joint, *not* from actuators
  - actuators used only to redirect power

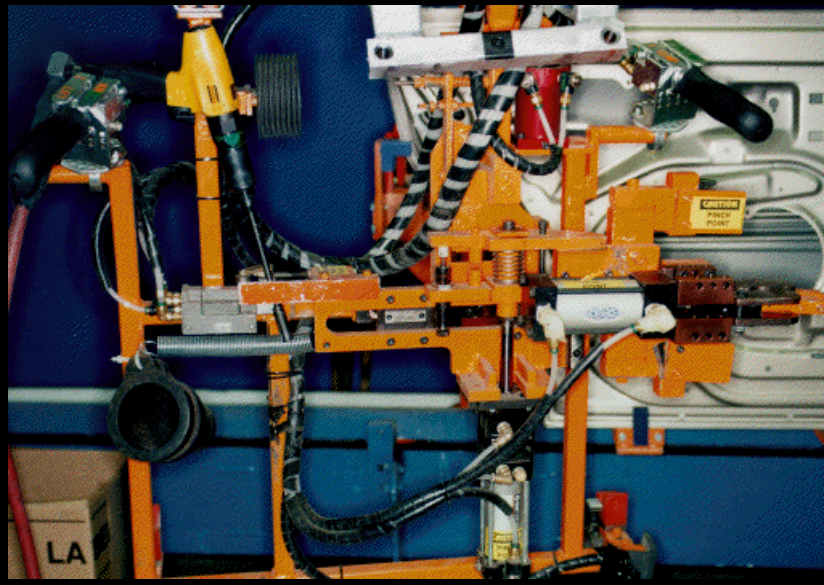
Concluding observations



Gripping

- Approaches:
  - human hand … perhaps augmented
  - standardized interface (e.g., pallets)
  - mechanical nightmares...

Tool for gripping a car door



Finally…
System Integration!

- Two keys:
- distributed intelligence & high speed serial communications (e.g. “FireWire”)
  - essential to minimize wire count and connector count
  - requires “smart” sensors and actuators
- “open architecture” environment for haptic systems